REPORT ON COMPUTER USAGE OF ACCOUNTS UNDER THE IBM/M.I.T. JOINT STUDY AGREEMENT: NEEMIS APPLICATION

NEEMIS Staff

Energy Laboratory in Association with
the Alfred P. Sloan School of Management

Working Paper No. MIT-EL-76-019WP

July 1976

IBM/M.I.T. JOINT STUDY PROGRESS REPORT - PART II

NEEMIS and State Applications

July 1976

CONTENTS

1. INTRODUCTION

This report provides a record of the use of the NEEMIS computational facility at the IBM Cambridge Scientific Center for the execution of studies and the development of application systems to assist New England energy planners.

Appendix A provides a list of the accounts being used for application development along with the names of the principal users and the purposes for which the accounts are being used.

Each of the following sections is devoted to an application.

2. FACTORS AFFECTING RESIDENTIAL HEATING OIL CONSUMPTION

2.1 Description of the Application

This study represents a concerted effort to identify and quantify factors affecting home heating oil consumption. Three econometric models and four data series comprise the framework of the analysis. Results of the study include a price elasticity of demand for home heating oil, a list of home and occupant characteristics that are significant factors in predicting home heating oil consumption, and a determination of some behavioral and physical energy-saving actions that lead to reduced consumption, In addition, there is an in-depth analysis of data biases. (See Appendix B: "Factors Affecting Residential Heating Oil Consumption," Donovan and Fischer, 1976 for a complete discussion of these findings.)

2.2 Computer Technology Used in Implementing the Application

Extensive use of VM, APL/EPLAN, CMS, SEQUEL, and the GMIS SEQUEL/APL interface enabled the authors (Donovan and Fischer) to undertake a rigorous and thorough analysis of their unique data. Magnetic tapes, CMS files, SEQUEL relations, and active APL workspaces hold the various data used in its many levels of aggregation and forms. The accessibility of these storage mediums and the flexibility of the NEEMIS environment greatly facilitated the analysis. In a conventional approach an analyst concentrates on one data series and uses one software package operating in a batch mode to reach his conclusions. Here we employ four series and a host of software while operating in an interactive setting, thus vastly enriching the quantity and quality of analysis while reducing the time-frame needed to complete the analysis.

2.3 Comparative Advantage of the Technology Used

The NEEMIS environment offers an ideal foundation for this type of study. The advantages are exemplified by a complete analysis of the many biases introduced by the data over the course of just one week. (This process is detailed in Donovan, 1976, "Database System Approach to Management Decision Support," see Appendix C). All data directly associated with this study and information utilized by other NEEMIS energy-related work is always readily available and can be quickly and efficiently transformed or incorporated into a form that is amenable to a given situation. This has enabled a much more far-reaching and probing analysis than could possibly have been achieved with a conventional apparoach.

2.4 Suggested Improvements

The analytical environment could be made even more suitable for this type of work if there were more efficient communication between analytical and database machines, if APL workspaces were allowed to dynamically expand in size as they became full, if a more coherent and well-documented statistical package were brought up in APL, and if an independent cross-sectional modeling capability were added to APL or to APL/EPLAN (to eliminate the need to constant "adjust" cross-sectional data into time series).

2.5 Lessons Learned in this Project

Future users engaged in similiar studies will find the completeness of hardware, software, and information found in the NEEMIS environment to be invaluable assets in their work. As the system continues to stabilize and as more analytical capabilities, operating systems software, and energy-related data are appended to the existing framework, the analyst can only be made more comfortable while oeprating within the NEEMIS context.

3. ENERGY CONSERVATION ANALYSIS AND MONITORING

3.1 Description of the Application

The purpose of this application is to give policymakers a facility to assist in: (1) formulating, (2) testing, and (3) monitoring conservation policies.

The application is more fully discussed in Appendix D.

3.2 Computer Technology Used in Implementing the Application

The nature of this application is one of the best examples of the need for a GMIS-type configuration. The problems associated with formulating and testing conservation policies in state buildings require a database capability and a modeling capability. The data is unknown, as is the structure of the models.

Similiarly, the problems associated with the monitoring aspects require a system that can access the data in ways not initially envisioned. We are unsure what monitoring reports the policymakers will want (e.g., plot of consumption by month of this year superimposed on a plot of consumption by month of last year, plot by month of consumption for a particular building relative to state average, etc.).

In response to these unique requirements, the following three systems either have been or will be built:

a) A prototype system presently used in Connecticut for both monitoring and testing. This system uses SEQUEL and PL/I.

b) Fixed "old fashioned" straw-man system. In an effort to study the effectiveness of the GMIS approach for building systems, Professor Donovan has permitted the development of a system for addressing only the monitoring aspects of conservation. This straw-man system has been designed using traditional technologies, namely, tape files and PL/I. We have already intuitively confirmed our philsophy that this approach may be very costly even for such a "fixed" application as monitoring. The system has taken over six months to design and probably will have to be redesigned to meet the current perceived needs. Studies of this system will provide quantitative numbers for a comparison of this "traditional approach" and the "GMIS" approach.

c) Flexible analysis and monitoring system. This system is presently being designed and implemented using SEQUEL and APL.

3.3 Comparative Advantage of Technologies Used

The modeling/database integration is allowing the rapid development of the flexible system for analysis and monitoring. Furthermore, studies comparing system (b) with system (c) will quantify our intuitive statements as to the costs of more traditional systems such as "straw-man."

It appears that further studies of system (a) should be conducted since reports from Connecticut indicate that performance is very poor (for example, they have reported two hours to load approximately 150 rows of consumption data into a table that contained approximately 1500 rows).

3.4 Suggested Improvements

The following technologies are desirable: (1) fast and efficient interfaces and (2) report generators coupled with SEQUEL.

3.5 Lessons Learned from this Application

We must devote more time to traning our own people as to the flexibility of the GMIS approach. Further attention must be given to training the state people in the flexibility of the GMIS approach.

It appears that the operational problem of SEQUEL's slowness has inhibited the adoption of the GMIS approach.

4. BUILDING ANALYSIS

4.1 Description of the Application

The purpose of the NEEMIS building energy analysis project is twofold. The first is to calibrate building energy needs. The finished system will provide a tool for use by the six New England states in calibrating energy usage in state-owned facilities. Coupled with a monitoring system, buildings that perform pporly (below what the model suggests) can be identified. Secondly, in order to analyze energy-saving improvements, once a program of energy-saving improvements has been selected for a given building, there remains the need to analyze the effectiveness of these improvements. The completed building energy analysis system will predict the effect of a given set of improvements on a given building. The immediate output will be in terms of gallons of oil, KWH's (killowat hours), or terms of natural gas saved. The economic analysis portion of the system will then convert these physical quantities to dollar savings, and then to present discounted value of improvements, payback period, and rate of return without investment.

The major focus of the work to date has been to select existing models that can perofrm these tasks, and develop a way of simplifying these models so that data needed can be readily obtained.

4.2 Computer Technologies Used

The main capability of the GMIS software being used for this project is the capability to run models developed on a different system. Two models ahve been identified as suitable. Each of these two models (as often is the case in a building heating and colling analysis model) is constructed of two submodels. The first submodel is usually called a load determination model and is primarily concerned with heat loss and heat gain. The second submodel is usually called the Heating Ventilation and Air Condition component simulation (HVAC). It is primarily concerned with converting loads into physical quantities of source energy forms.

In the NEEMIS application the NECAP model had the best HVAC section but a poor load determination section. The National Bureau of Standards Load Determination (NBSLD) model had the best load determination program. Both NECAP and NBSLD are written in FORTRAN. However, NECAP was written one a control data machine for NASA by a private company contracted by Langley Space Flight Center, whereas NBSLD was written at the National Bureau of Standards in Maryland. The problem is that these two model programs are incompatible with each other. The Construction Engineering Research Laboratory started writing interfaces between the two in FORTRAN. Texas A&M has written some of these interfaces in assembler language. As yet, however, no one has succeeded.

Our approach is to use the GMIS modelling integration approach where each model is executing on its own VM and communicating through a common data base machine.

Thisapproach and the submodels are depicted in Figure XX.

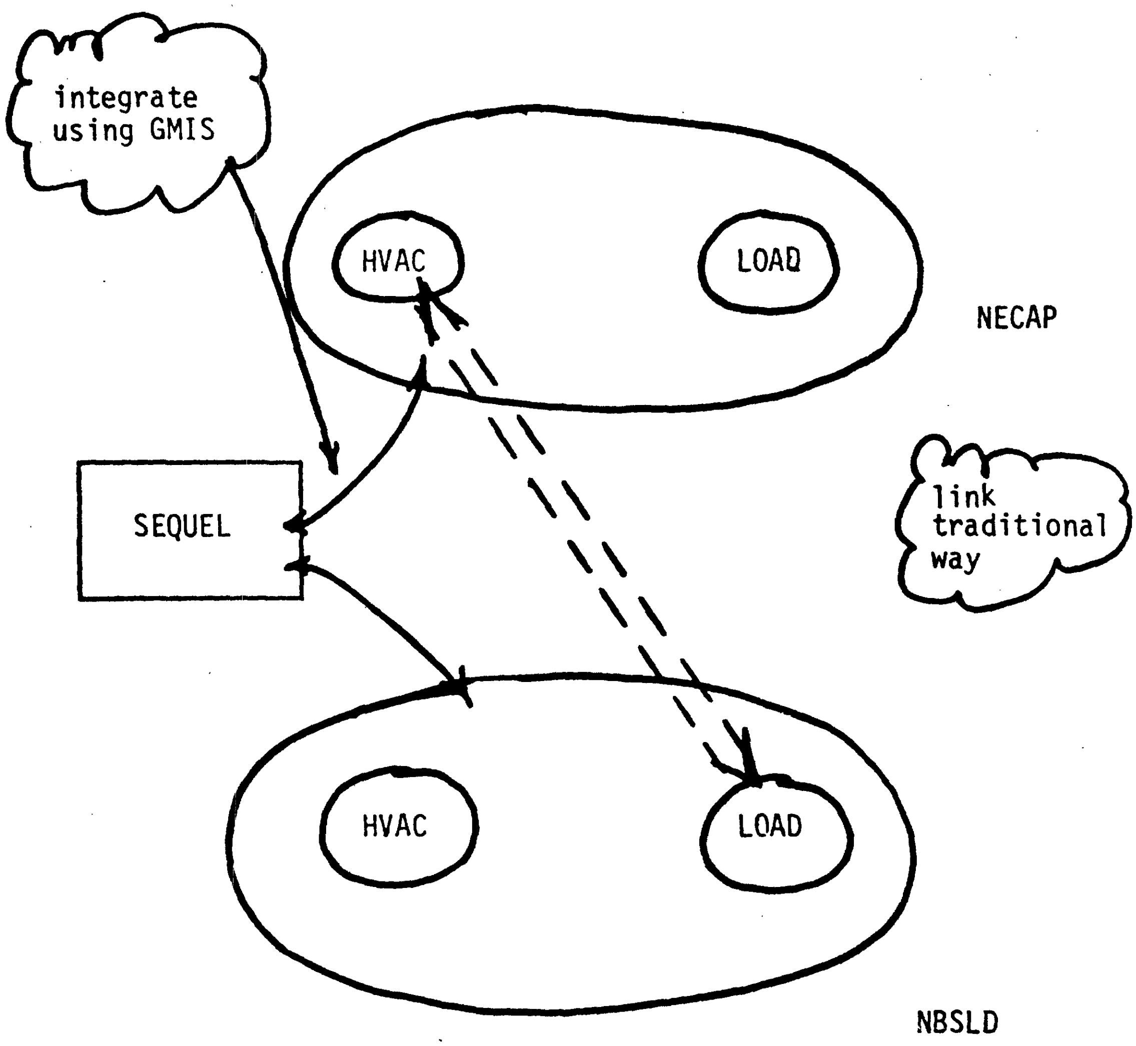

Figure XX. Integration of Submodels of NECAP and NBSLD

4.3 Comparative Advantage of These Technologies

An advantage of the GMIS software in this project is the abilty to integrate existing models quickly and have them access common data.

4.4 Suggested Improvements

A secondary problem has been the incompatibility of FORTRAN between the Control Data machine and the IBM equipment. The models are apparently sensitive to the different tolerances introduced in a 60-bit word versus a 32-bit word. Software or documentation to make the appropriate conversion in the FORTRAN code would be helpful.

4.5 Lessons Learned from this Project

The following are the lessons we have learned.

- Confirmation of the GMIS concept for model integration.
- Incompatibility between Control Data, FORTRAN, and IBM.
- There is simply too much data needed by NECAP. We sent a data sheet for a building to each of the state energy officers. They all said it was too detailed.
- It takes one man one week per building to fillout the questionnaire.
- That much data is not necessary and often is redundant. For example, air leaks around windows may not be significant in a well-ventilated office building.
- A management problem in NEEMIS is that we do not have enough systems people who know the modelling integration aspects to do all the applications.

5. STATE AUTOMOBILE REGISTRATION ANALYSIS

Preface Note: Professor Donovan has numerous objections to this design. It does not state its purpose clearly; it does not use the technology to match its purpose; it makes technical mistakes; it is poorly written. Specifically, the purpose of this application is to provide a facility for analysing policy questions that center around automobiles in a state. His major objection is that this design focuses around producing a few restricted reports rather than focusing around providing a general capability. For example, it would be difficult and costly to reprogram the system to answer such questions as: "Is a proposed automobile tax schedule a regressive or progressive tax?" The system can not easily allow for analysis of both registration fees anc excises taxes.

The application is now under careful review. We have included the description not as an example of a good implementation, but rather, to illustrate significant expenditure of personal time and some computer time.

5.1 Description of the Application

The State Automobile Registration Analysis (SARA) System is a set of programs designed to produce both a vehicle registration profile analysis and a tax revenue analysis.

5.1.1 Vehicle Registration Profile Analysis

The vehicle registration profile analysis will include frequency tables on the follwoing car characteristics: year, zip code, MPG (city, highway, and average), weight (shipping, curb, and inertial), engine displacement, and horsepower. These frequency tables will be given for the state as a whole, and if the user wishes, for each town and county. A breakdown into rural and urban areas will also be given if the user so desires.

5.1.2 Tax Revenue Analysis

The tax revenue analysis will provide tax revenue totals for the state as a whole or by town, county, or rural/urban designation. The tax revenue totals can be based on a flat registration fee or a graduated scale (as selected by the operator) based on any one of the car's characteristics (e.g., weight, MPG, etc).

5.2 Computer Technologies Used in this Application

Three systems are in varying degress of completeness at this time:

(1) a prototype system that is operational in the state of Vermont and is primarily written in APL;

(2) a system primarily written in PL/I; and

(3) an APL/SEQUEL system.

5.3 Comparative Advantage of Technolgoy Used

Two features of the VM version at the Cambridge Scientific Center have been particularly useful in implementing systems (1) and (2): the ability to switch easily from a CMS environment to an APL environment and back again, and the accessibility of SEQUEL tables and CMS files from different environments.

5.4 Suggested Improvements

Less abrupt enforcement of storage and disk space limits would be helpful.

6. PERFORMANCE EVALUATION OF INTERMACHINE INTERFACES AND COMMUNICATION

6.1 Description of Application

This study represents an effort to quantify and graphically portray the costs involved in interface overhead between modeling and database machines. Queries of increasing complexity requesting linearly increasing quantities of data were issued from an APL machine to a SEQUEL database machine. Results showed that regardless of the quantity of data involved, complex queries result in a small percent of time spent in the interface machine. Similarly, it was found that the amount of data transferred is linearly proportional to the time spent in the various interface routines (these results are more fully reported in Appendix F).

6.2 Computer Technologies Used and Their Comparative Advantage

VM, APL, SEQUEL, and associated GMIS interfaces were all used extensively in this analysis. The ease with which timing mechanisms could be implanted into the interfaces greatly facilitated the analysis. The results are consistent with what one would expect to find but the fact that precise and tangible measurements could be secured is most unusual. Very few studies of this nature are able to produce this sort of result.

6.3 Suggestions for Improvement

Conclusions of the analysis show that efforts should be made to reduce the time it takes SEQUEL to process complicated queries; intermachine communication should be made more efficient; and more attention should be given to optimizing interface coding.

6.4 Lessons Learned in this Application

It is possible to define queries which are ordinally related along the dimension "complexity."

7. INTERFACE BETWEEN TSP AND THE GMIS DATA MANAGEMENT SYSTEM

7.1 Description of the Application Area

An interface between TSP and the GMIS data management system is being developed to enable TSP users to extract time series data from the GMIS database and be able to store results back into the database. In order to use these features, it has been necessary to adopt a convention for storing time series data in a SEQUEL database.

The scope of this project includes the code which runs the modeling virtual machine. The functions performed by this code are to:

- fetch the command string from TSP's dynamically allocated storage
- pass the command string to the interface VM
- receive data from the interface VM
- insert the data into TSP's dynamically allocated storage

The code is written in Pl/I and FORTRAN for use with TSP, which is written in FORTRAN.

7.2 Computer Technology Used in the Application

The use of the GMIS architecture is central to the design of the TSP interface since TSP and the data management system are operating in different virtual machines at the same time, while a third virtual machine performs the formatting operation necessary to interface to the standard TSP and SEQUEL interface specifications.

The SPY feature is used to transfer commands and data from the modeling VM to the VM which formats it for the interface with the data management system (see Appendix C).

7.3 Comparative Advantage of this Technology

The GMIS architecture enables users to be running different models written in different languages at the same time while accessing a common database.

7.4 Improvements to Facilitate the Application

Better and more efficient communication mechanisms are needed.

7.5 Lessons Learned from this Application

We have been able to extend the limited data handling capabilities of of TSP with those advanced capabilities of SEQUEL. This has been possible because of the architecture of the GMIS system. Further, we found it more efficient to change TSP to run under CMS

8. STATE APPLICATIONS

Since the states have obtained terminals, the states have become significant users of the NEEMIS computational facility. Massachusetts, Connecticut, and Vermont now have their own terminals, and Maine is expecting delivery of a terminal by the end of July, 1976.

Primary projects in process by the states involve the states' use of the computational facility and are as follows:

8.1 Vermont

1. Determine effect of oil embargo on natural gas consumption;
2. Predict the growth characteristics and future price of electricity as underpinnings for an education pamphlet aimed at the lay public;
3. Compile accurate data on energy consumption in Vermont by two digit SIC code;
4. Analyze trends in automobile registration and impact of alternative registration fee schedules;
5. Predict changes in energy consumption by automobiles as price of gasoline changes (this will be based on data from a socio-economic questionnaire sent to state residents);
6. Collect and analyze data from residential sector for primary and secondary heating fuels, peoples perception of energy problems and attitudes toward conservation alternatives such as the state subsidizing installation of insulation, taxing heavier cars more, etc.;
7. Predict present and future energy consumption in the state to rebut latest straw-man data from FEA.

8.2 Connecticut

1. Use of Connecticut Interactive Demand Projection System (CIDPS) for twenty demand projections.
2. Prepare contingency plan for shortages of natural gas. Connecticut is compiling an end-use inventory for natural gas.
3. Operation of Prototype Energy Conservation Analysis and Monitoring System for 71 Connecticut state facilities.

8.3 Massachusetts

1. Predict impact of alternative electric utility rate schedules on the various classes of users.
2. Analyze energy consumption of municipal buildings with the objection of categorizing buildings into groups whose members have similiar energy consumption characteristics.
3. Analyze responses to Project Conserve questionnaire.

9. MANAGEMENT EVALUATION OF IMPLEMENTATION PROCESS

This application was to use the system for statistical analysis of data on the implementation process. It has turned into a reporting use of the computer primarily using SCRIPT. As such, its access to the machine has been terminated.

APPENDIX A

CURRENT USES OF IBM ACCOUNTS FOR NEEMIS APPLICATION DEVELOPMENT

The following tables categorize projects by users, specific accounts used in each project, and specifies in a general way the GMIS function used in each project.

Table I lists projects of the M.I.T.-NEEMIS personnel, Table II lists state users, and Table III lists the users associated with the advanced modeling projects under Dave Wood's supervision.

Note that effective July 27 state accounts will in general be restricted to use for corresponding state applications. Further, all uses listed in Table III have been terminated pending submission of reports and proposals.

In general, the following personnel have been responsible for monitoring each account:

Lou Gutentag - NEEMIS 7, NEEMIS 8, GMIS, GMIS 1, GMIS 2, GMIS 3

Dave Wood - NEEMIS 1, NEEMIS 5, NEEMIS 12, NEWHAMP, CONN, and part of NEEMIS 10

George Berry - all others

TABLE 1: PROJECTS OF IBM/NEEMIS PERSONNEL

Person	Project	Accounts: Conn.	Mass.	R.I.	Maine	Vermont	N.H.	NEEMIS	NEEMISA	NEEMIS2	NEEMIS3	NEEMIS4	NEEMIS5			NEEMIS9	NEEMIS10	NEEMIS11	NERCOM		FISCHER	Contract Categories: Training & Opr.	Publishing	Maintain Applications	Maintain Data	Computational Facility	Day to Day Questions	Long Term Studies	Short Term Studies	PFF	New Data	Other
John Maglio	program conservation monitoring maintain NEEMIS data library on NEEMISA respond to queries train state users	PD	PD					D PD PD	PD										P			X			X		X	X				
Tony Smith	program conservation monitoring															PD												X				
Marta Greenberg	solar heating model program conservation monitoring			P PD																								X	X			
Peter DiGiammarino	testing DYNAMO in GMIS environment testing "breadboarding," "Boston City Fiscal Project," "Decision Support in Health" performance of APL/SEQUEL interface home heating study				DE DE			DE		PD P P							P				PED											X X X X
Eric Michelman	state automobile registration system																		P										X X			
Jim Leape	training									P												X										
Tom Birney	building analysis program										P																	X				
Jim Peters	prototype consumption monitoring system										PD	PD																	X			
Dick Tabors	training																					X										
Alan Banks	enter car data			I									E																		X	
Jenny Rankin	enter car data						E											E													X	

Key: P = programs, analytical facility
D = SEQUEL database
E = enter data

TABLE II: STATE USERS

User	Project	Accounts: Conn.	Mass.	Maine	Vermont
Connecticut					
Marc Hoffman	operate Conn. Interactive Demand Project System	X			
	query fuel storage capacity by county	X			
Al Johanson	contingency planning for natural gas shortage	X			
Doris Lester	enter data for consumption monitoring	X			
Massachusetts					
Harvey Michaels	calculate impact of new electric rate schedule		X		
John Haynes	categorize buildings according to their energy usage characteristics		X		
Maine					
Dick Darling	training			X	
Mark Foster	training			X	
Vermont					
Bob Radcliffe	training				X
	model nat. gas consumption during oil embargo				X
	project demand for electricity				X
	automobile tax analysis program				X
Rod Spivey	load and analyze energy use data for agri-culture				X

TABLE III: Advanced Modeling

ENERGY LAB AND SLOAN SCHOOL USERS

User		NEEMIS 10	NEEMIS1	NEEMIS5	NEEMIS12	NEW HAMP.	RHODE ISL.	CONN.
David E. White	Extend Brookhaven RES to finer end user categories		X					
Steven Hnyilicza and Bob Pindyck	OPCON time series optimization program				X	X		
Steven Hnyilicza and Kai Wong	Macro energy model for U.S.				X			
Steven Hnyilicza and World Oil	Game theory model of cartel behavior				X			
Ross Heide	Load data for World Oil model			X				
Martha Donahue (for Bob Alloway)	Use SCRIPT for Alloway's paper						X	
Bob Hall and David Lillian	Macroeconomic modeling							X
Martin Zimmerman and Mike Baumann	U.S. Coal Supply	X						

APPENDIX B

"FACTORS AFFECTING RESIDENTIAL HEATING ENERGY CONSUMPTION"

See Energy Laboratory Working Paper

No. MIT-EL-76-004WP

APPENDIX C

"DATABASE SYSTEM APPROACH TO MANAGEMENT DECISION SUPPORT"

See CISR Report No. 25

APPENDIX D

"CONSERVATION ANALYSIS AND MONITORING SYSTEM"

CONSERVATION ANALYSIS AND MONITORING SYSTEM

George Berry

July 1976

1. Introduction

Conservation planning, testing, and monitoring in state buildings is an important area. This document describes the facility developed by NEEMIS to accomplish those tasks. Among the important features of the NEEMIS approach to conservation analysis are:

1) The system is operational;
2) The system uses an unusual approach for data gathering in that there is an automated procedure by which the vendors send all delivery data directly to NEEMIS headquarters. The data is verified, stored, and retrieved.
3) The system uses the advanced computational capability of GMIS to quickly produce individual reports on pertinent data;
4) The GMIS modeling and data handling capability facilitates analysis and formulation of new policies.

2. Importance of Conservation Program in State Buildings

2.1 Large Dollar Savings Possible

With the dramatic increase of the price of energy since 1972/73 and with the accompanying fiscal hardships that have occurred in state and local governments, methods of conserving energy have become important. A small percent of reduction in consumption (for example, energy expenditures by the executive branch of the Commonwealth of Massachusetts is roughly $65 million, or 3% of the total budget) could represent large dollar savings.

2.2 Possible Funds Available for Implementing Programs

Through Public Law 94-163, the states have been mandated the responsibility of developing policies for energy conservation in the domestic, commercial, and industrial sections. Each state is eligible to receive funds for such efforts. (A total of $150,000,000 over the next three years has been allocated).

2.3 Leadership Role

It is important for the states to offer a leadership role in the development of policies and programs to conserve energy. Any call by the state for the private sector to conserve must be substantiated with evidence of state conservation.

3. Functions of System

Figure 1 depicts functions involved in conservation analysis, the role of the parties involved, and the interactions between the function and the NEEMIS computational facility.

3.1 Data Collection

The most valuable lesson learned from our experience in developing a system in Connecticut was that it is both difficult and time consuming

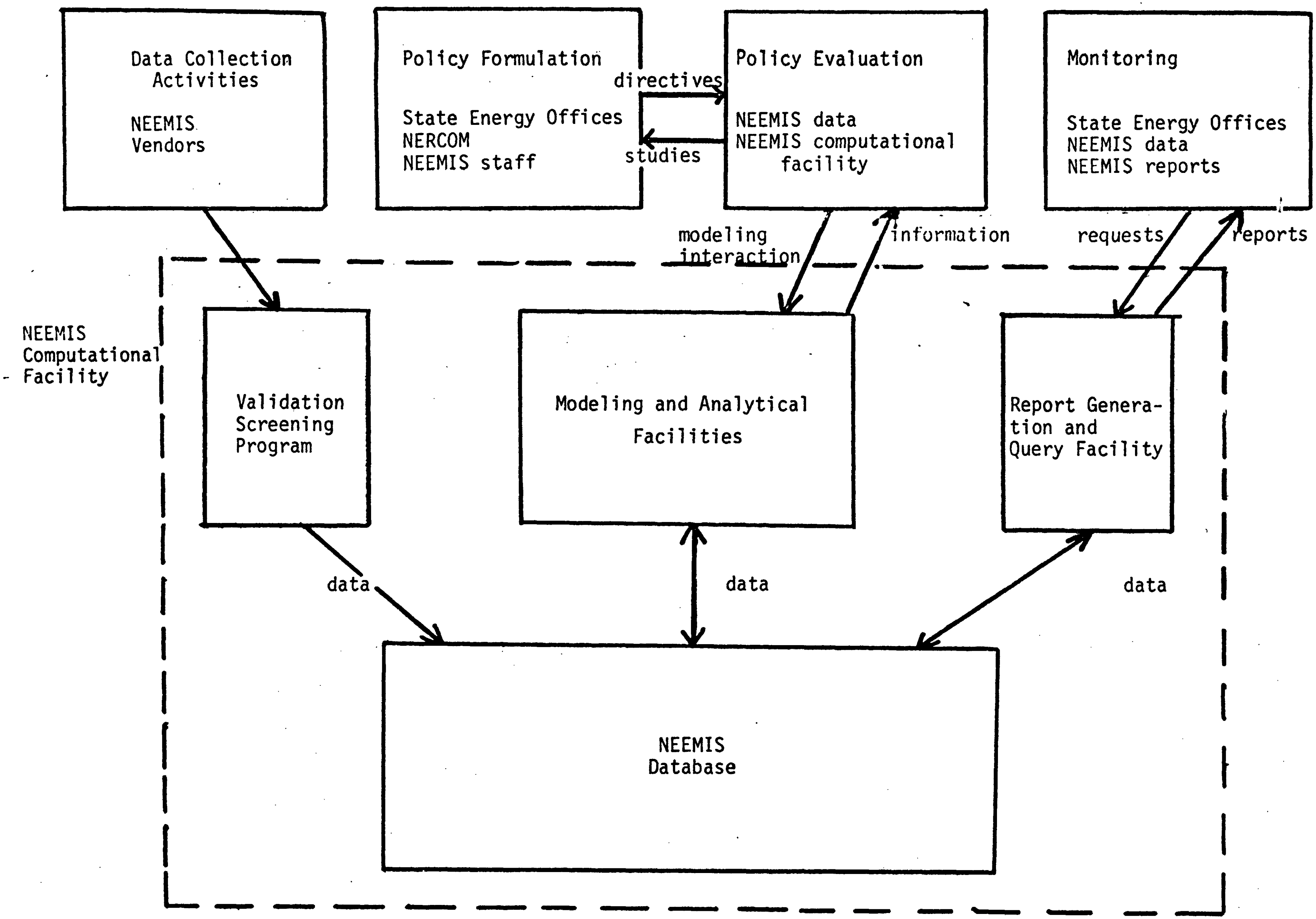

Figure 1: Simplified Schematic Diagram of Conservation Analysis and Monitoring Functions

to collect accurate consumption data from the end customer. Hence, starting in 1976 a different approach has been taken. Some New England states with the assistance of NEEMIS staff have initiated a contract whereby all contracts with fuel vendors require that delivery data be sent in machine-readable form to NEEMIS headquarters, thus automating the data collection process without spending additional time or state resources. The NEEMIS computational facilities have been programmed to validate and store this data in the NEEMIS data base.

All data in the NEEMIS system is stored in the form of tables. The following three tables are central to the conservation monitoring effort.

Energy by Month

Consumer ID	Energy Form	Year	Delivery Period	Amount	BTU	Costs

Consumer

Consumer ID	Name	Weather Station	Position of State in Hierarchy	Heating Area	Characteristics of Building

Vendor

Name	Vendor or Consumer ID	Consumer ID	Energy from	Characteristics of Vendor

Each row in the "Energy by Month" table corresponds to a delivery. Each row of the "Consumer" table corresponds to a consumer sight. Each row of the "Vendor" table corresponds to a vendor providing energy to buildings.

Among other pertinent data series stored in NEEMIS are weather, census, economic trends. Most importantly the NEEMIS computational facility allows the assimilation, storage, and retrieval of new data series quickly and inexpensively.

3.3 Policy Formulation

Whether to reduce state expenditures, to be in compliance with PL94-163, or to offer a leadership role to other public or private sectors, there exists a strong need for states to formulate conservation policies to redirect consumption of energy in state buildings. The formulation task is accomplished by the state energy offices, regional state officials, and by whatever assistance the NEEMIS economists and energy planners can provide. Examples of plausible policies would be: thermostate setback, carpooling, physical changes to buildings, etc. The NEEMIS facility can serve as a focal point of exchange of ideas of such policies and as a mechanism for testing and evaluating them.

3.4 Policy Evaluation

This formulation involves studying the implications of a proposed or existing policy. NEEMIS can assist in formulating studies and in implementing these studies in terms of data gathering and modeling. A good example of such a study is the recent NEEMIS study on factors affecting residential home heating where the effects of price increases, increases in awareness, and physical changes in homes were studied Testing the impact of particular methods of carpooling, alterations to buildings, temperature resetting, etc. is possible using NEEMIS's computational facility.

Stored in the NEEMIS database is consumption data, building characteristics, weather data, price data, socio-economic data and other data series which would be likely to be used in such policy testing. Further, the NEEMIS computational facility has a variety of statistical packages and modeling facilities available, as well as flexible data management systems.

3.5 Monitoring and Consumption

Operational on the NEEMIS computational system are programs to produce a series of standard reports. Two of these reports are: the Executive report and the Detailed Report. The executive report gives montly consumption information (amount by fuel type) aggregated by major departments, making explicit comparison with prior year's consumption admusted for weather. The detailed report gives similar interactions for each consumer and any specified groups of consumers.

As part of the system there is a flexible on-line query language which enables an operator at a terminal to formulate many types of unplanned, context dependent queries about the data. Examples of this query language are given below where the question is formulated on the left and the corresponding computer query is on the right:

Question	Query
How much money did the state spend on all forms of energy during the first 5 months of the year?	SELECT TOS (COST) FROM ENERGY_BY_MONTH WHERE YEAR = 1976 AND MONTH BETWEEN 1 AND 5;
Which energy vendors sell residual fuel oil to the state?	SELECT NAME FROM VENDOR WHERE ENERGY_FORM = 6;
How much money did the state spend on energy for facilities at the Department of Health in 1975?	SELECT TOT (COST) FROM ENERGY_BY_MONTH WHERE YEAR = 1975 AND CONSUMER'S ID = SELECT CONSUMER_ID FROM CONSUMER WHERE HIERARCHY BETWEEN DHEAAAAAA AND DHE999999;;

3.5 Assist in Disputes

NEEMIS can assist the state in providing support data and documentation of states efforts to comply with federal mandates. For example, in PL94-163, the FEA makes heavy use of the PIES model to project future state energy use. It is likely that because of the assumption within this model some states may be given unfair treatment. It is likely that other means of projection state energy conservation efforts may be developed. The availability of the NEEMIS facility enhances the New England states ability to develop such means. Presently the NEEMIS staff is developing a set of leading indicators of energy conservation efforts.

4. Summary

In summary NEEMIS may play a number of roles in assisting states with their conservation planning, testing, and monitoring efforts. Four of these roles are significant with respect to PL94-163 and are of importance to immediate state efforts to conserve fules. These roles are as follows:

policy formulating, policy testing/evaluation, monitoring of energy use, and support states as they compare the achievements of their conservation plans with FEA's projections.

At present, the NEEMIS staff ean assist in the initial policy formulation required for planning phase of PL94-163, both in formulating policy and in terms of testing the likely impacts of those policies. During the implementation stage NEEMIS can be of assistance both in the design of sampling procedures and in the monitoring of energy use as well as the testing and evaluation of policies. NEEMIS offers to the states a support system built upon a strong database and analytical capability with which individual states or the region can use to determine their own actions and to present to the FEA their analysis of energy saved.

References:

Donovan, J.J., Fischer W.P.: "Factors Affecting Residential Heating Energy Consumption", M.I.T. Energy Laboratory Working Paper No.: MIT-NEEMIS-76-002TR, July 1976.

Donovan, J.J., Jacoby, H.D.: "GMIS: an Experimental System for Data Management and Analysis", M.I.T. Energy Laboratory Working Paper NO.: M.I.T.-EL-75-o11WP, September 1975.

Donovan, J.J.: "Database System Approach to Decision Support," Center for Information Systems Report No: CISR-25, July 1976.

APPENDIX E

ELEMENTS OF PROTOTYPE ENERGY CONSERVATION ANALYSIS AND MONITORING SYSTEM

This appendix describes the prototype energy conservation analysis and monitoring system now operational in Connecticut. This system was developed using PL/I and SEQUEL. Figure E1 depicts the interaction of the SEQUEL relations and the PL/I analytical routine. Figures E2 through E9 describe each relation.

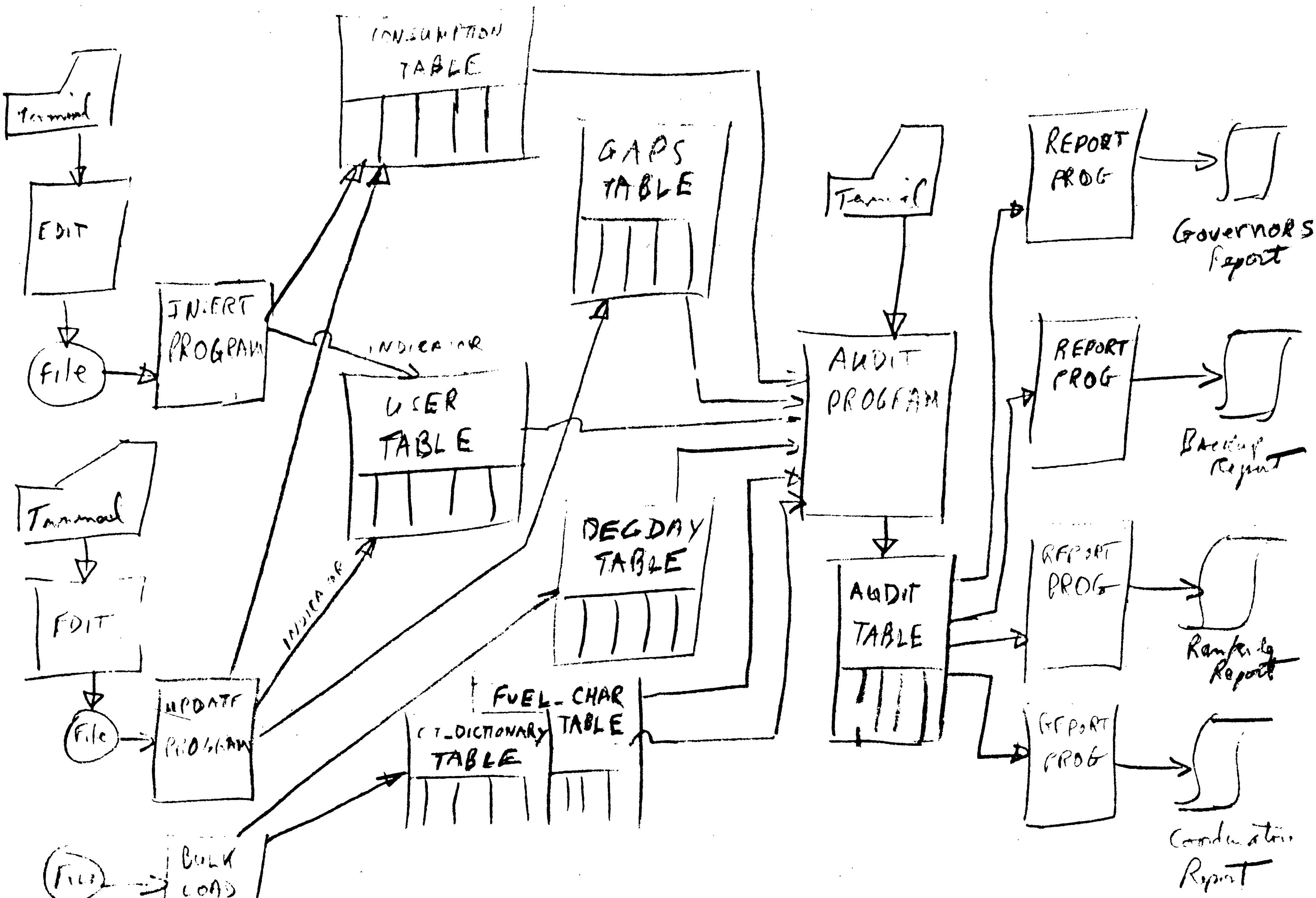

Figure E1: Prototype Energy Conservation Analysis and Monitoring System

DESCRIPTION OF TABLE CT_DICTIONARY

NAME	DOMAIN	TYPE	C	KEY	INV
ABBRV	ABBRV_OR_CODE	CHAR	1	YES	NO
MEANING	EXPRESSION	CHAR	1	NO	NO
TYPE	ABBRV_OR_C_TYPE	CHAR	1	YES	NO

Figure E2: Relation containing Hierarchy in State

DESCRIPTION OF TABLE CT_USERS

NAME	DOMAIN	TYPE	C	KEY	INV
----	------	----	-	---	---
USER	NAME	CHAR	1	YES	NO
S	SECTOR	CHAR	1	NO	NO
D	DEPARTMENT	CHAR	1	NO	NO
SD	SUBDIVISION	CHAR	1	NO	NO
A	AGENCY	CHAR	1	NO	NO
F	FACILITY	CHAR	1	NO	NO
FIRST_REP	DATE	NUM	0	NO	NO
LAST_REP	DATE	[illegible]	[illegible]	[illegible]	[illegible]
WTHR_STATION	TOWN	CHAR	1	NO	NO
E_COORD	NAME	CHAR	1	NO	NO
USER_NAME	NAME	CHAR	1	NO	NO
STREET	ADDRESS	CHAR	1	NO	NO
CITY	ADDRESS	CHAR	1	NO	NO
TELEPHONE	TELEPHONE	CHAR	1	NO	NO

Figure E3: Relation containing User Information

1. Hierarchy codes
2. Last and first reporting dates
3. Weather station (for weather normalization)
4. Energy Coord. Information

DESCRIPTION OF TABLE CT_CONSUMPTION

NAME	DOMAIN	TYPE	C	KEY	INV
USER	NAME	CHAR	1	YES	NO
S	SECTOR	CHAR	1	NO	NO
D	DEPARTMENT	CHAR	1	NO	NO
SD	SUBDIVISION	CHAR	1	NO	NO
A	AGENCY	CHAR	1	NO	NO
F	FACILITY	CHAR	1	NO	NO
MONTH	DATE	NUM	0	YES	NO
V_ALL	VER_CODE	CHAR	1	NO	NO
V02	VER_CODE	CHAR	1	NO	NO
OIL_2	GALLONS	NUM	0	NO	NO
V04	VER_CODE	CHAR	1	NO	NO
OIL_4	GALLONS	NUM	0	NO	NO
V06	VER_CODE	CHAR	1	NO	NO
OIL_6	GALLONS	NUM	0	NO	NO
VN	VER_CODE	CHAR	1	NO	NO
NAT_GAS	CUBIC_FEET	NUM	0	NO	NO
VE	VER_CODE	CHAR	1	NO	NO
ELECT	KWH	NUM	0	NO	NO
VG	VER_CODE	CHAR	1	NO	NO
GASOLINE	GALLONS	NUM	0	NO	NO
VP	VER_CODE	CHAR	1	NO	NO
PROPANE	GALLONS	NUM	0	NO	NO
VS	VER_CODE	CHAR	1	NO	NO
STEAM	LBS_X_1000	NUM	0	NO	NO
VC	VER_CODE	CHAR	1	NO	NO
COAL	LBS_X_2000	NUM	0	NO	NO

Figure E4

Monthly Consumption Relation

1. hierarchy codes

2. month of report

3. verification codes for entire report
   (is entire record complete?)

4. fuel amounts & verification codes for each fuel

Verification Codes: 'M'--missing entry
'N'--fuel not in use
'T'--new (unverified) entry
'b̸'--data has been verified by energy office and/or energy coordinator

DESCRIPTION OF TABLE CT_FUEL_CHAR

NAME	DOMAIN	TYPE	C	KEY	INV
YEAR	DATE	NUM	0	YES	NO
FUEL	FUEL	CHAR	1	YES	NO
UNITS	QUANTITY_UNITS	CHAR	1	NO	NO
BTU	BTU_PER_QTY	NUM	0	NO	NO
COST	COST_PER_QTY	CHAR	1	NO	NO

Figure E5: Fuel Relation

DESCRIPTION OF TABLE CT_CONS_GAPS

NAME	DOMAIN	TYPE	C	KEY	INV
USER	NAME	CHAR	1	YES	NO
S	SECTOR	CHAR	1	NO	NO
D	DEPARTMENT	CHAR	1	NO	NO
SD	SUBDIVISION	CHAR	1	NO	NO
A	AGENCY	CHAR	1	NO	NO
F	FACILITY	CHAR	1	NO	NO
MONTH	DATE	NUM	0	YES	NO

Figure E6

Contains one row for each missing report (row) in CT_CONSUMPTION. For each user, between FIRST_REP and LAST_REP (first and last reporting dates from CT_USERS) there is one row for each month in either CT_CONSUMPTION or CT_GAPS.

DESCRIPTION OF TABLE DEGDAY

NAME	DOMAIN	TYPE	C	KEY	INV
---0	------	----	-	---	---
STATION	STATION	NUM	0	YES	NO
TOWN	TOWN	CHAR	1	NO	NO
FY	YEAR	NUM	0	YES	NO
QTR1	DEGDAY	NUM	0	NO	NO
QTR2	DEGDAY	NUM	0	NO	NO
QTR3	DEGDAY	NUM	0	NO	NO
QTR4	DEGDAY	NUM	0	NO	NO
FY_TOTAL	DEGDAY	NUM	0	NO	NO

Figure E7: Degree-day Relation

DESCRIPTION OF TABLE CT_AUDIT_75744N

NAME	DOMAIN	TYPE	C	KEY	INV
----	------	----	-	---	---
USER	NAME	CHAR	1	YES	NO
LEVEL	LEVEL	CHAR	1	NO	NO
S	SECTOR	CHAR	1	NO	NO
D	DEPARTMENT	THAR	1	NO	NO
SD	SUBDIVISION	CHAR	1	NO	NO
A	AGENCY	CHAR	1	NO	NO
F	FACILITY	CHAR	1	NO	NO
FUEL	FUEL	CHAR	1	YES	NO
QTR_CONS	QUANTITY	NUM	0	NO	NO
BQTR_CONS	QUANTITY	NUM	0	NO	NO
QTR_SAVINGS	QUANTITY	NUM	0	NO	NO
QTR_PER_SAVINGS	PERCENT	NUM	0	NO	NO
QTR_DOL_SAVINGS	DOLLARS	NUM	0	NO	NO
QTR_MBTU	MBTU	NUM	0	NO	NO
QTR_REP_IN	REPORTS	NUM	0	NO	NO
QTR_REPORTS	REPORTS	NUM	0	NO	NO
BQTR_REP_IN	(EPORTS	NUM	0	NO	NO
BQTR_REPORTS	REPORTS	NUM	0	NO	NO
QTR_DEGDAY	DEGDAY	NUM	0	NO	NO
BQTR_DEGDAY	DEGDAY	NUM	0	NO	NO
YR_CONS	*UANTITY	NUM	0	NO	NO
BYR_CONS	QUANTITY	NUM	0	NO	NO
YR_SAVINGS	QUANTITY	NUM	0	NO	NO
YR_PER_SAVINGS	PERCENT	NUM	0	NO	NO
YR_DOL_SAVINGS	DOLLARS	NUM	0	NO	NO
YR_MBTU	MBTU	NUM	0	NO	NO
YR_REP_IN	REPORTS	NUM	0	NO	NO
YR_REPORTS	REPORTS	NUM	0	NO	NO
BYR_REP_IN	REPORTS	NUM	0	NO	NO
BYR_REPORTS	REPORTS	NUM	0	NO	NO
YR_DEGDAY	DEGDAY	NUM	0	NO	NO
BYR_DEGDAY	DEGDAY	NUM	0	NO	NO

Figure E8

"N" in table name indicates weather normalization
4th quarter F475
base year F474

Audit table created as output of auditing and aggregation process

"CONS"--consumption
"QTR"--quarter
"BQTR"--corresponding qtr in base year
"YR"--year to date
"BYR"--corresponding base year
"MBTU"--British Thermal Units x 10^6
"PER"--percentage over base
"DOL"--dollar
"DEGDAY"--degree day (65° F)
"REP-IN"--number of reports actually received for a given unit in a given period
"REPORTS"--number of reports that should have been received from a given unit

DESCRIPTION OF TABLE CT_AUDIT_75744

NAME	DOMAIN	TYPE	C	KEY	MV
USER	NAME	CHAR	1	YES	NO
LEVEL	LEVEL	CHAR	1	NO	NO
S	SECTOR	CHAR	1	NO	NO
D	DEPARTMENT	CHAR	1	NO	NO
SD	SUBDIVISION	CHAR	1	NO	NO
A	AGENCY	CHAR	1	NO	NO
F	FACILITY	CHAR	1	NO	NO
FUEL	FUEL	CHAR	1	YES	NO
QTR_CONS	QUANTITY	NUM	0	NO	NO
BQTR_CONS	QUANTITY	NUM	0	NO	NO
QTR_SAVINGS	QUANTITY	NUM	0	NO	NO
QTR_PER_SAVINGS	PERCENT	NUM	0	NO	NO
QTR_DOL_SAVINGS	DOLLARS	NUM	0	NO	NO
QTR_MBTU	MBTU	NUM	0	NO	NO
QTR_REP_IN	REPORTS	NUM	0	NO	NO
QTR_REPORTS	REPORTS	NUM	0	NO	NO
BQTR_REP_IN	REPORTS	NUM	0	NO	NO
BQTR_REPORTS	REPORTS	NUM	0	NO	NO
QTR_DEGDAY	DEGDAY	NUM	0	NO	NO
BQTR_DEGDAY	DEGDAY	NUM	0	NO	NO
YR_CONS	QUANTITY	NUM	0	NO	NO
BYR_CONS	QUANTITY	NUM	0	NO	NO
YR_SAVINGS	QUANTITY	NUM	0	NO	NO
YR_PER_SAVINGS	PERCENT	NUM	0	NO	NO
YR_DOL_SAVINGS	DOLLARS	NUM	0	NO	NO
YR_MBTU	MBTU	NUM	0	NO	NO
YR_REP_IN	REPORTS	NUM	0	NO	NO
YR_REPORTS	REPORTS	NUM	0	NO	NO
BYR_REP_IN	REPORTS	NUM	0	NO	NO
BYR_REPORTS	REPORTS	NUM	0	NO	NO
YR_DEGDAY	DEGDAY	NUM	0	NO	NO
BYR_DEGDAY	DEGDAY	NUM	0	NO	NO

TRANSACTION COMPLETED.

READY:

Figure E9: Audit Relation

APPENDIX F

"TRADITIONAL" STRAW-MAN CONSUMPTION MONITORING SYSTEM

This appendix includes a specification of the "traditionally" designed consumption monitoring system, as well as data gathering procedures.

Energy Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

TO: Distribution

FROM: George Berry, NEEMIS Coordinator

SUBJECT: Conservation Monitoring

DATE: February 6, 1976

ATTACHMENTS:

(1) Stage One Energy Monitoring System
(2) Questions on the Stage One Energy Monitoring System

Purpose

Attachment 1 describes the energy consumption monitoring system which has been designed for use by the New England states.

The purpose of this letter is to distribute the specifications and an accompanying questionnaire to state energy officials as a prelude to finding out what changes if any will be required to have a system which will be usable by all the states.

Attachments

The system as described in Attachment 1 consists of (1) data gathering activities to be accomplished by the states' personnel on a routine basis (for those states which wish to participate) and (2) a set of computer programs available on the NEEMIS computer (reference to "GMIS" should be read as references to "NEEMIS").

Attachment 2 is a questionnaire about the system.

Requirements on States

As currently planned, the primary requirements on a state which wants to use the system are:

- State must have computer terminal ($120 per month rental and telephone charge)

- State must have energy coordinator to report energy consumption by each facility to be monitored

- State must have person at a central site to key data into computer.

System Highlights

Highlights of what the NEEMIS computer does are:

- Accepts and validates input to data management system (routine input consists of consumption by a state facility which may be for any administrative unit from a single building to an entire agency.)

- Keeps record of expected entries which are missing

- Normalizes consumption for weather

- Produces consumption reports aggregated for different levels of state government

Installation

A NEEMIS installation team will visit each state to train state personnel during the initial start up period.

Addendum

Just after these specifications were completed, a change was suggested based on the desire to monitor consumption at several thousand sites in one state. Serious consideration is being given to dispensing with validation of data at each site for correctness of entry into the computer. Instead, it is proposed that most validation be done at the state's central site based on a system of batch totals.

Current Situation

Pilot test of a simplified version of the system will begin in mid February 1976.

Action

Please study attachment 1 for applicability to your state. Then consider the questions in attachment 2. The NEEMIS staff will contact you soon to discuss this project with you. Mr. Robert Keating has suggested I send these attachments directly to you.

QUESTIONS on the stage one energy monitoring system (NEEMIS)

The Basic System

1. Will the assignment of the energy co-ordinator tasks to individuals in the various state agencies be a problem in your state? If so, what is (are) the problem(s)?

2. Are there means of obtaining data on energy consumption for your state agencies other than the proposed energy co-ordinators? If so, what are they? Would this (or these) methods be preferrable to energy co-ordinators? What actions and how much time would it take to implement the method(s)?

3. Would your state energy office be able to carry out the tasks assigned to it in the stage one system (i.e., obtain a remote computer terminal link via telephone to NEEMIS, assign personnel to input data and handle output). If not, why not?

4. What do you think of the analysis which the system performs (i.e., consumption, % energy savings, estimated financial savings)?

5. How might the output (analysis) of the stage one system be used in your state?

Operations

6. Would the monthly consumption and quarterly analysis cycles be the most useful in your state? If not, what cycles would be better?

7. What do you think of the output report types? Is the correct information included in each report? Is the report format acceptable?

8. What do you think of the input procedures (including the operations and the forms)?

Summary

9. Would you be able to use the system as it presently stands? If not, why not?

10. Would you want to use the system as it presently stands? If not, why not?

11. How could the system be altered to better meet your state's needs?

12. Are the goals of the stage two system the most useful follow up of the stage one system as far as you are concerned? If not, what would you suggest?

STAGE ONE

ENERGY MONITORING SYSTEM

(New England Energy Management
Information System)

T. Birney
J. Peters
January 20, 1976

I. INTRODUCTION

The Stage One Energy Monitoring System provides the New England State Governments with a feedback on their energy conservation strategies and policies for state agencies. Central to the system (see figure 1) are:

- "Energy co-ordinators" in the various state agencies who report the energy consumption of their agencies to the central energy office.

- A central energy office at the state level which receives data and issues reports relating to consumption and conservation of energy by state agencies and is linked via remote computer terminal and telephone to NEEMIS.

- NEEMIS with its GMIS (Generalized Management Information System) computer facility which stores and processes the data relating to energy consumption and conservation.

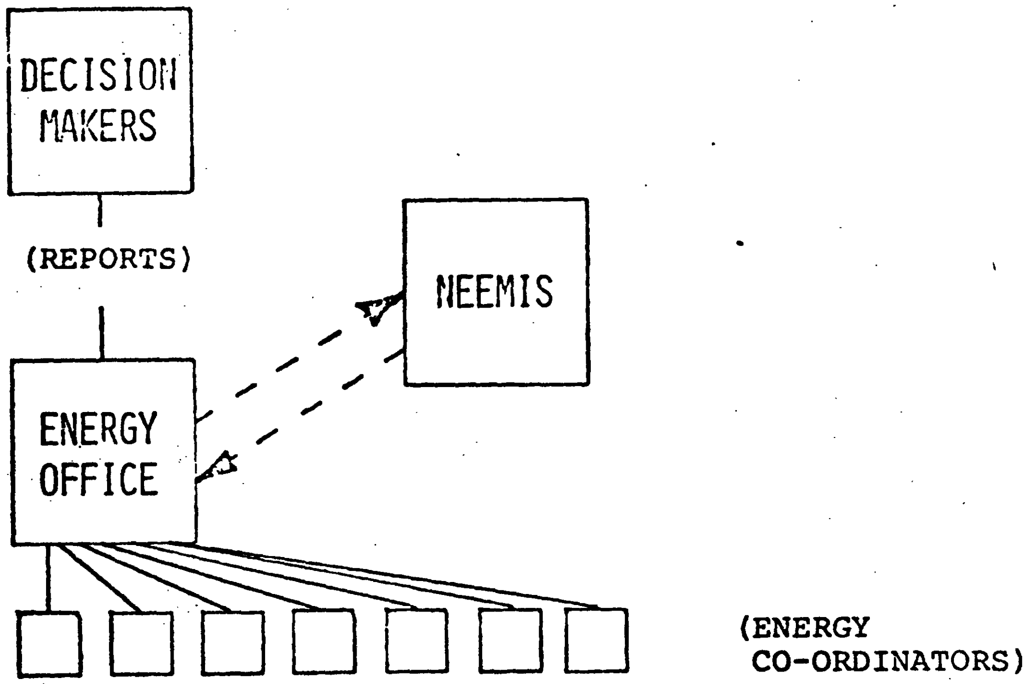

Figure 1

The system monitors the energy consumption of State agency users, adjusts for weather, determines the energy and estimated financial savings over previous periods (for each government level from the individual consumer to the state as a whole), identifies major consumers of energy and serves as the framework for a more advanced second stage system.

NEEMIS would be responsible for the implementation of the system in each state. The state energy offices would be responsible for most of the on-going operations.

II. OPERATIONS

The following operating patterns and procedures are recommended to insure data accuracy, smooth data flow and meaningful output.

(Input Data)

The system makes use of four categories of input data: data on each energy user (identification, characteristics), characteristics of the fuels in use (BTU, estimated cost), weather (degree days), and fuel consumption by state agency users (quantity).

User and fuel characteristic data are provided and input by the state energy office whenever there are new agency or facility users or whenever new data becomes available on fuels.

Weather data is provided and input by NEEMIS on a monthly basis.

Data relating to energy consumption is reported by energy co-ordinators to the energy office on a monthly basis. It is the energy co-ordinator's responsibility to: 1) gather and record consumption information for an agency or facility (allocating that consumption to the proper month and fuel type). 2) check the record against data returned to the energy co-ordinator for verification, and 3) send in a montly report which includes: energy consumption (by fuel type) for the month, verification of the previous month's data, and adjustments (if any) to reports of previous months' consumptions and verifications (see figure 1 and figure 2 in the Appendix for sample energy co-ordinator reporting forms).

All energy co-ordinator reports are logged in as they are received by the state energy office (see figure 2 in the appendix for a sample from an energy office logbook page). One monthly report is expected from each energy co-ordinator. Any consumption data reported in addition to the one monthly report requires a special submission control code which is obtained from the energy office prior to submission. The data is keyed into the system by state energy office personnel at the state energy office and enters the data base via a computer program which is a part of the system.

(Data Base)

The data is maintained in a data base on the GMIS facility and includes data on the structure of the state government, individual state energy users, weather, fuel consumption by state users and previous standard analytical outputs of the system. The data base is routinely accessed by stage one computer programs for data entry and the printing of standard reports. In addition, the data can be recalled or aggregated (totaled, averaged, etc.) selectively by energy office personnel.

(Computer Programs)

The system contains several computer programs and subprograms, dealing with data base input, data analysis, and output. After keying data for a reporting period into the temporary input file, energy office personnel initiate the input program (at least once a month) which moves the data to the proper locations in the data base and prints output directly related to that input (new data entries for verification, missing data entries, unacceptable data entries).

Programs also exist which print individual consumption analyses in standard format (see section on output) or full reports in standard format. These programs aggregate consumption data by user, date, status of the data in terms of verification and fuel type (including energy total), normalize oil consumption figures by weather (heating season severity), and compute the percent fuel savings and estimated financial savings over a choosen (by the the energy office) base year period.

Other programs rank energy users by quantity of consumption and list the large users accounting for 20% of total consumption.

(Output)

There are three categories of stage one system output apart from selective manipulations of the data base using GMIS:

- output resulting directly from input (new data entries for verification, missing data entries, unacceptable data entries). This output goes to the energy co-ordinators (monthly).

- output in standard report format (see figure 4 appendix for standard report format), is in the form of individual analyses or four standard quarterly reports. The reports are: a Governor's Report, a Back-up Report to the Governor's Report, Energy Office Report, and Energy Co-ordinator Reports (see figures 5a-5d Appendix for a listing of the components of each report and see figure 6 Appendix for a page from a sample report). The reports include da·a on con-ump-tion performance (including consumption, % energy savings (normalized by weather for oil) and estimated financial savings (normalized by weather for oil) during a quarterly period and for the year to date, for the selected users.

- output identifying large consumers (ranking of users by quantity of consumption, listing of large users accounting for 20% of total consumption) (quarterly).

III. SUMMARY

The Stage One Energy Monitoring System inputs data relating to energy consumption on a monthly basis and outputs standard reports on a quarterly basis (modifications by state energy offices must be in multiples of the original cycles). The basic components of the system are energy co-ordinators (in the state agencies), the central energy office and NEEMIS.

IV. STAGE TWO SYSTEM

A second stage system is planned for development following the implementation of the first stage system. The second stage system makes use of additional data:

- on physical characteristics of user facilities
- on user vehicles
- on fuel cost
- on fuel suppliers
- on costs and benefits of potential capital improvements

The second stage system will use the first stage system as a framework but will improve on the accuracy of the first stage system and will perform the additional function of identifying facilities for which energy saving capital improvements may be cost effective.

APPENDIX

(The energy co-ordinator fills out a full energy report once a month for the previous month's consumption for each fuel listed. The quantity of consumption is either the number of gallons, cubic feet, kilowatt-hours, etc. consumed, 0 if the capacity to consume exists even though there was no consumption, NIU if the fuel is not in use at the present time, or NA if there was consumption but the figures are not yet available. The energy co-ordinator must also report the consumption of any unlisted fuels (in comments section), and verify the figures (which the system is using) for the previous report. See figure 1.)

(The energy co-ordinator fills out an update report whenever there are new figures to be entered for a previously reported period or whenever there is a verification to be made outside of the regular monthly reporting cycle. The new figures may be corrections or previously unreported consumption. See figure 2)

ENERGY CONSUMPTION DATA (MONTH)

________________ Date (Month)

____________________________ User Name (Abbrev.)

	Consumption
Oil #2 (Gal.)	__________
Oil #4 (Gal.)	__________
Oil #6 (Gal.)	__________
Natural Gas (Cu. ft.)	__________
Electricity (KWH)	__________
Propane (Gal.)	__________
Gasoline (Gal.)	__________
Steam (1000 lbs.)	__________
Coal (2000 lbs.)	__________

___ Check if previous month's consumption is verified for all fuels

____

____

____ (Comments)

____
Energy Co-Ordinator

____
Date

Figure 1
(Sample Monthly Energy Co-Ordinator Report Form)

ENERGY CONSUMPTION DATA (UPDATE)

________________ Date (Month)

____________________________ User Name (Abbrev.)

Check one:

_____ Update only (new entries listed below replace prior entries)

_____ Verification only (figures for all fuels)

_____ Verification and update (verification of figures for all fuels except those listed below with new consumption figures)

Fuel Type	Consumption

____

____

____(Comments)

____
Energy Co-Ordinator

____
Date

Figure 2
(Sample Energy Co-Ordinator Update Report Form)

ENERGY CO-ORDINATOR REPORTS

Date	Submission Code	User	Date Received	Batch #
7601	NONE	Ch. Hosp. Phy. Plnt.	7602-19	4
"	"	Ch. Hosp. Out Pat.	7602-16	3
"	"	Vet. Hosp. Phy. Plnt.	7602-19	4
"	"	Vet. Hosp. Out Pat.	7602-19	4
"	"	Dept. of Hosp.	7602-15	2
"	"	Dept. of Pub. Hlth.	7602-15	2
⋮				
"	7601-23	DEPT. OF HOSP.	7603-2	11
"	7601-24	DEPT. OF PUB. HLTH.	7603-3	11

Figure 3
(Sample Energy Office Logbook Page)

(For each regular monthly submission by the energy co-ordinators, the central energy office logs the submission with only the date the submission is for, the name of the agency or facility, and the date the submission was received. Additional reports must use a submission code. The list of users for logging in the regular montly submissions is printed out by the computer. The submissions are grouped into batches for the purpose of control prior to being keyed into the system.)

Name	Quarter* Date	Fuel	Units	Consumption	Base Year	% Savings	$ (Est.) Savings	% Completeness of Data
UCONN-ST	770001	Oil #2	Gallons	110,000	76	13	1,000	90

* or year to date

Figure 4
(Standard Report Format)

(Every analysis is in a standard format which includes: 1) the name of the unit being analyzed, 2) the period (date) to which the analysis applies, 3) the fuel consumption which is being analyzed (including total energy as a fuel type), 4) the units of consumption (i.e., BTU, Gallons, Cubic feet, etc.), 5) the quantity of consumption, 6) the percent savings for the period's consumption over the same period for the previous year (or another base year chosen by the energy office), 7) estimated financial savings based on present fuel cost figures for the energy saved over the previous (or other base) year, 8) %-completeness of the data upon which the analysis is based.)

(The system outputs standard reports on a quarterly basis. See Figures 5a through 5d for the contents of each report.)

I. GOVERNOR'S REPORT (Quarterly)

A. Energy used by fuel type (including total energy), % energy savings over the same period previous (or other base) year, estimated financial savings over the same period previous (or other base) year, and completeness of data (for the quarter and the year to date) for:

- state government as a whole
- each state government department (listed by sector)

Figure 5a

(Contents of Standard Reports)

II. BACK-UP REPORT to the Governor's Report (Quarterly)

A. Energy used by fuel type (including total energy), % energy savings over the same period previous (or other base) year, estimated financial savings over the same period previous (or other base) year, and completeness of data (for the quarter and the year to date) for:

- state government as a whole
- each state government department (listed by sector)
- each state government agency listed by sector, department and subdivision

B. List of large agency users accounting for 20% of total consumption (ordered by consumption).

Figure 5b
(Contents of Standard Reports)

III. ENERGY OFFICE REPORT (Quarterly)

A. Energy used by fuel type (including total energy), % energy savings over the same period previous (or other base) year, estimated financial savings over the same period previous (or other base) year, and completeness of data (for the quarter and the year to date) for:

- state government as a whole
- each state government department (listed by sector
- each state government agency listed by sector, department and subdivision
- each state government facility listed by sector, department, subdivision and agency

B. List of large agency users accounting for 20% of total consumption (ordered by consumption).

C. List of large facility users accounting for 20% of total consumption.

D. List of users not reporting data for the period.

Figure 5c

(Contents of Standard Reports)

IV. ENERGY CO-ORDINATOR REPORTS (Quarterly)

A. Energy used by fuel type (including total energy), % energy savings compared to the same period previous (or other base) year, estimated financial savings compared to the same period previous (or other base) year, and completeness of data for the quarter and the year to date) for the user to which the individual energy co-ordinator is attached.

Figure 5d

(Contents of Standard Reports)

(a typical page of a regular output report might look like figure 6a. the user and the fuel types are listed. there are entries for the quarter and the year to date for: 1) quantity of consumption, 2) units of consumption (i.e. BTU, Gallons, etc.), 3) normalized savings over previous or other base year, 4) % energy savings over previous or other base year (normalized), 5) estimated financial savings over previous or other base year (normalized), 6) completeness of the data upon which the analysis is based. See figures 6a-6c)

FORTRAN Coding Form

FORTRAN STATEMENT on 8 1/2 x 11 sheet

GOVERNOR'S REPORT ON ENERGY CONSUMPTION
(SECOND QUARTER, FY 1975 - BASE FY 1974)

DEPARTMENT	QTR OR YR TO DATE	BTU USAGE (BILLIONS)	BTU SAVINGS	$ (EST) SAVINGS	% BTU SAVINGS	DATA COMPLETE
DEPT OF HOSP	QTR	23600	1050	20000	15	100%
	YRTD	42000	2010	31000	13	100%
DEPT [illegible] WORKS	QTR	86004	3001	266282	9	100%
	YRTD	104056	4000	370050	8	100%
consists of departments						
TOTALS	QTR	8230000	120000	1360000	9	97%
	YRTD	14062000	900000	2000000	6	95%

Figure 6a

IBM

FORTRAN Coding Form

PART 2 OF GOVERNOR'S REPORT

FORTRAN STATEMENT

ANALYSIS BY FUEL TYPE (OIL SAVINGS FIGURES HAVE BEEN NORMALIZED TO EQUALIZE WEATHER CONDITIONS)

FUEL	QTR OR YR TO DATE	CONSUMPTION	SAVINGS	PERCENT SAVINGS	$ (EST) SAVINGS	DATA COMPLETENESS
OIL 2	QTR	100000	10000	3	3000	95%
(GALLONS)	YR TD	600000	15000	3	4500	94%
OIL 4	QTR	100000	20000	20	7000	98%
(GALLONS)	YR TD	180000	22000	12	8000	98%
remainder of fuels						
COAL	QTR	1000	130	13	3900	100%
(TONS)	YR TD	1700	150	10	4400	100%

Figure 6b

*A standard card form, IBM electro 888157, is available for punching statements from this form

**Number of forms per pad may vary slightly

[illegible]
[illegible] FY 1974
(ALL FIGURES HAVE BEEN NORMALIZED TO EQUALIZE WEATHER
CONDITIONS IN ALL 'SAVINGS' COLUMNS.)

	QTR OR YR TO DATE	AMOUNT USED	BASE PERIOD AMT. USED	AMOUNT SAVINGS	% AMT. SAVINGS	$ (EST) SAVINGS	CURR PERIOD DEGREE DAYS	BASE PERIOD DEGREE DAYS
[illegible]								
[illegible]	QTR	[illegible]	1450	50	2	18	2300	2400
(GALLONS)	YRTD	[illegible]	2950	50	2	15	2560	2620
GASOLINE	QTR	600	700	100	15	60		
(GALLONS)	YRTD	[illegible]	1350	120	9	80		
[illegible]	QTR	[illegible]	[illegible]	[illegible]	10	[illegible]		
[illegible]	YRTD	[illegible]	[illegible]	3400	3	3450		
[illegible]								
[illegible]	QTR	[illegible]	572	72	13	25	2250	2300
(GALLONS)	YRTD	950	1030	80	6	27	2460	2490
[illegible]	QTR	600	720	120	18	120		
[illegible]	YRTD	832	1000	168	7	168		

FIGURE 6C

APPENDIX G

"GMIS" APPROACH TO CONSUMPTION ANALYSIS AND MONITORING

Figure G1 depicts the relations used in the flexible system which is presently being implemented.

SEQUEL Tables in Energy Conservation Analysis and Monitoring System

Deliveries_JJJ*
- submitter_ID
- vendor_ID
- consumer_ID
- energy_form
- sulphur
- start_date
- last_date
- quantity
- charge
- peak_load
- rate_class
- data_form

Consumer_JJJ
- mnemonic
- consumer_ID
- hierarchy_key
- name
- type
- usage
- weather
- heated_area
- cooled_area
- window_area
- wall_area
- elec_rate

Fuel_use_JJJ
- consumer_ID
- fuel type
- use
- percent

Jurisdiction_JJJ
- hierarchy_key
- address

Vendor_range
- vendor_ID
- jurisdiction

Ven_consum_JJJ
- vendor_ID
- ven_consumID
- consumer_ID

Ven_fuel_JJJ
- vendor_ID
- ven_consumID
- fueltype

Weather
- station
- year
- month
- degday
- wind

Vendor
- vendor_ID
- name
- address
- tel

* JJJ is jurisdiction code

APPENDIX H

"A NOTE ON PERFORMANCE OF VM/370

IN THE INTEGRATION OF MODELS AND DATABASES"

See Energy Laboratory Working Paper

No. MIT-EL-76-018WP